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THE DANISH INGOLF-EXPEDITION.

VOLUME I.

4.

CURRENT-BOTTLES.

BY

C. F. WANDEL.

WITH 1 PLATE.

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In «The Ingolf-Expedition», first Volume no. 1, Pages 18—20, under the Article «Current-bottles» an account will be found of the throwing overboard of current-bottles, the place of throwing, description of the bottles and the landing-place of those bottles, which had been found, when the Article was printed.

Since that time 4 bottles more have been found and there is not much probability, that others will appear, so we may suppose, that the time to analyze the obtained result has come. There is the more reason to believe this, as the bottles already found have diverged very little in their course and the appearance of more bottles will hardly have any influence on the result. The following table indicates the course of the bottles found.

Specification
of
the places where the current-bottles were thrown and the landing-places of those hitherto found.

Nr.	Date	Time	Lat. N.	Long. W.	Found
1	$^{19}/_{7}$ 96	9^{20} AM.	66° 19′	13° 46′	October 1898. Mikkel-Vig, Skage-Sund, 32 miles North of Tromsø. Northern coast of Norway.
2	$^{19}/_{7}$ -	NOON	66° 17′	13° 01′	$^{17}/_{1}$ 98 Sør-Arnø, 14 miles SW. of Bodø, Western coast of Norway.
3	$^{19}/_{7}$ -	3 PM.	66° 16′	12° 09′	
4	$^{19}/_{7}$ -	5 —	66° 32′	11° 47′	$^{4}/_{1}$ 97 Kongshavn on Østerø, Færoe-Islands.
5	$^{20}/_{7}$ -	12^{20} AM.	66° 48′	11° 17′	$^{26}/_{3}$ 97 Bud. Romsdal, Western coast of Norway.
6	$^{20}/_{7}$ -	2^{30} —	66° 58′	10° 39′	$^{16}/_{6}$ 98 Mokka-Fjord, Murman-coast, Russia.
7	$^{20}/_{7}$ -	4^{30} —	67° 09′	10° 00′	
8	$^{20}/_{7}$ -	6^{35} —	67° 17′	9° 20′	$^{10}/_{10}$ 96 Langesand on Strømø, Færoe-Islands.
9	$^{20}/_{7}$ -	2^{40} PM.	67° 16′	8° 30′	$^{10}/_{6}$ 97 Makur, East-Finmarken, Northern coast af Norway. 1)).
10	$^{20}/_{7}$ -	4^{35} —	67° 30′	7° 55′	
11	$^{20}/_{7}$ -	6^{38} —	67° 41′	7° 23′	
12	$^{20}/_{7}$ -	8^{42} —	67° 55′	6° 50′	$^{28}/_{1}$ 98 Tanahorn, Finmarken, Northern coast of Norway.
13	$^{21}/_{7}$ -	7^{20} AM.	68° 12′	6° 44′	
14	$^{21}/_{7}$ -	10 —	68° 30′	6° 44′	$^{17}/_{8}$ 97 Renø, Bustad-Sund, Northern coast of Norway.
15	$^{21}/_{7}$ -	12^{30} —	68° 49′.5	6° 44′	$^{29}/_{11}$ 97 Laxe-Fjord, Northern coast of Norway.
16	$^{21}/_{7}$ -	3^{30} PM.	69° 10′.5	6° 44′	$^{19}/_{1}$ 98 Røst, Lofoten, Western coast of Norway.
17	$^{21}/_{7}$ -	7^{10} —	69° 31′	6° 06′	$^{21}/_{6}$ 97 Vopna-Fjord, Eastern coast of Iceland.
18	$^{22}/_{7}$ -	7 AM.	69° 58′	7° 06′	$^{21}/_{1}$ 98 Blixvær, 9 miles West of Bodø, Northern coast of Norway.
19	$^{22}/_{7}$ -	12^{30} PM.	70° 25′	7° 11′	
20	$^{22}/_{7}$ -	5 —	70° 44′	8° 41′	$^{3}/_{12}$ 96 Skoruvik on Langanæs, Northern coast of Iceland.

The object of throwing current-bottles is to discover the direction and force of the current between the spots of their throwing and landing. Their course can only be stated exactly, if the

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1) Nr. 9 does not appear on Table 1, as information concerning it was received during the printing.

landings take place evenly scattered on the routes of the bottles. In stating the exact speed the length of time elapsed, after the landing of the bottles, must be taken into consideration.

Circumstances have not favored the experiments, which have been made. The bottles could only reach land at three places, namely on Iceland, the Færoe-Islands and the coast of Norway, and these coasts are so thinly populated, that a bottle may lie long before it is found.

All the bottles have undoubtedly drifted with the East-Icelandic Polar-current; some have landed on the Færoe-Islands, while the greater part has reached the Western coast of Norway. With our knowledge of the East-Icelandic Polar-current, the passage of the bottles to the Færoe-Islands can be drawn with approximate exactness; we can only imagine their directions between the Færoe-Islands and Norway. Along the Western coast of Norway the bottles follow the current running northwards, and from the date, when the relatively first bottles were found, we can ascertain the slowest speed they can have had and thereby also judge of the speed of the current.

The bottles — 20 in number — were thrown during the period from the 19th to the 22nd of July 1896 on «Ingolf»s voyage from Langanæs to Jan Mayen. The places, from where the bottles were thrown, are shown on the attached chart with ° and a figure, which indicates the number of the bottle. The place, where the respective bottle has been found is indicated by a X with corresponding number and date. The curves indicate the routes, which the bottles are supposed to have taken.

According to our knowledge of the direction of the currents at Iceland and especially on account of what has been stated on this matter in the section «Hydrography» of this report, page 117 and following, there cannot be any doubt, that the movement of all the bottles has in the beginning been towards the South, following the East-Icelandic Polar-current and then towards the East, following this current in the direction of the Færoe-Islands; it is not very likely, that they have passed very much to the South of these islands, as they must have been stopped here by the Gulfstream-water going North-East and we cannot suppose either, that they have gone very much to the North of the islands, judging from the direction taken by bottle no. 8.

The routes of the bottles must be supposed to converge somewhat towards the Færoe-Islands.

Those of the bottles, which have drifted as southerly as the Færoe-Islands and have not been found there, have passed outside of or between the Færoe-Islands and have finally landed on the Western coast of Norway.

When the bottles have first come into the neighbourhood of the Færoe-Islands, they will be drawn into the whirlpool, which runs round these islands and is due to the action of the local tide. Their courses might then cross each other, for the arrival of a bottle one hour sooner or later within the whirlpool may cause it to take a very different direction.

It is not possible to state (and it might be due to mere chance), how many times a bottle might drift round or pass between the islands, if it does not land, but there cannot be any doubt, that the courses of the bottles have crossed each other, while they have been in the neighbourhood of the Færoe-Islands and that the bottles have left the Færoe-Islands in a very different order to that, in which they arrived.

If we now take into consideration the drifting of the different bottles separately, then we shall see, that bottle no. 20, which was thrown near Jan Mayen, was found about $4^1/_2$ months later at Langanæs; this bottle must therefore have drifted with a speed of at least 2,4 miles in 24 hours and there is reason to believe, that the speed has been even greater judging by bottle no. 8. The last mentioned bottle was found on the Færoe-Islands about 2½ months after it had been thrown and it has accordingly travelled with a speed of at least 4,0 miles during 24 hours, from which it may be concluded, that the speed of the surface-water of the East-Icelandic current is at least as great. The two current-bottles no. 20 and no. 8 and especially the latter have been found so soon after they were thrown, that it may be concluded, that they have not made any circuit worth speaking of in passing between their throwing- and landing-places. The same may be supposed as regards bottle no. 5, which was found at Bergen about 8 months after it had been thrown. If it be supposed, that this bottle has travelled southwards to the Færoe-Islands and then to Bergen, its average speed will have been at least 2,9 miles during 24 hours. If it be supposed in the same way, that bottle no. 15 has travelled as shown on the chart, its average speed will have been at least 3,3 miles during 24 hours and the average speed of bottle no. 12 has been about the same.

As regards the other bottles, which have been found much more to the North and much later, it may be supposed, that they have been found long after landing or after having reached their place of landing, where local currents have kept them drifting about; it cannot be supposed, that they have travelled once round the North-Atlantic, before they have reached the Western coast of Norway, as this would mean a rotation-speed, which is quite out of the question.

Some of the routes of the bottles West of the Færoe-Islands cross each other; all the bottles having been thrown in the same kind of water, i. e. in the East-Icelandic Polar-current and with so short intervals, that it could hardly be supposed, that two bottle-routes would cross each other in the open sea, such crossings could only take place near the shore and could only be occasioned by the circumstance, that one bottle lands, while the other remains distant from the coast, or that one of the bottles is caught by a special coast-current, while the other does not reach so far, or finally, that one bottle is kept near the coast for some time, while the current, which runs along the coast, changes its direction. These remarks apply to the routes taken by bottles no. 17, 18 and 20.

If it be supposed, that the drifting of the bottles has been approximately as indicated in the chart, we shall find, that the water of the East-Icelandic Polar-current between 65° and 70° Northern latitude has moved in a southwesterly direction towards the North-Eastern coast of Iceland. A movement in such a direction will cause a diminuation of the Polar-current-area between Iceland and Jan Mayen as Gulfstream-water must follow from the East and North-East. It is generally known, that the Polar-currents usually diminish during the summer and have their smallest extent at the beginning of the autumn and we learn accordingly from the drifting of the bottles, that this increase of the Gulfstream and decrease of the Polar-current owe their existence to the fact, that the surface-water in the East-Icelandic Polar-current moves towards the South-West, and with the surface-water goes probably partly the whole icewater stratum. As it has been pointed out in «Hydrography», page 122, it cannot be expected, that the understratum of the Polar-current, which at its Eastern side consists of Gulfstream-water, participates in this movement of the icewater to any marked extent. While the whole bulk of icewater in this way alters its extent from one season to the other, the very uppermost part of the icewater, the real surface-stratum, which during the summer is considerably warmed up, as is shown on page 137, can move quite independent of that icewater, to which it originally belongs. Such movements can be caused by the wind and can perhaps also have assisted to carry the surface-water with the bottles towards the South-West. When the bottles nos 1—12 were thrown the wind was light, chiefly coming from the South-West, when bottles nos 13—16 were thrown, the wind turned through the South-East to the North, but was continuously very light. The bottles nos 17—20 were thrown, when the wind was northnorthwesterly of strength 3 (Beaufort). During «Ingolf»s return-voyage from Jan Mayen to Iceland the wind was all the time very light. It is therefore not to be supposed, that the wind can have had any particular influence on the drifting of the bottles. Very little is known about the mean direction of the wind in these waters. It appears however from the meteorological observations, that the wind at the Northern coast of Iceland is on an average easterly during the months of July and August. If it may be concluded, that the direction of the wind is usually the same in the Ocean North of Iceland, then the wind will also have contributed to carry the current-bottles inwards towards the North-Eastern coast of Iceland. We must suppose, that the bottles deviate towards the South-East about on 65° Northern latitude and follow the Polar-current towards the Færoe-Islands.

The bottles have now arrived at the line of contact between the Gulfstream and the Polar-current. We do not know the further course of the last mentioned, whether it runs round a circle in the Western North-Ocean or whether its circular course has even a greater diameter. In the summer of 1896 it could be traced North of the Færoe-Islands and there is hardly any doubt, that it enters the Eastern part of the North-Ocean. The question now to be decided is whether the bottles can be carried from the Polar-current into the Gulfstream.

The specific gravity of the bottles was only very little less than that of the water, and as a bottle in this way only offers a very little surface for the action of the wind, it can hardly be supposed, that the wind has driven the bottle with a speed worth considering; in accordance herewith it must be supposed, that the wind cannot change the course of the bottle, causing it to go from the Polar-current into the Gulfstream. On the other hand, if it be supposed, that the water, in which the bottle is thrown, sinks down under other water strata, the bottle will not follow the water stratum, to which it belongs, but will pass into the water stratum, which is uppermost. This however can not take place in the present case. The water, in which the bottles were thrown contained 32—33 ‰ salt. While this water runs southwards, it is in contact with the cold and somewhat salter bulk of the icewater and thereby its contents of salt are somewhat increased. Its temperature also increases, the summerheat from the air having more effect than the cold water below. When the bottles have arrived in the neighbourhood of the Atlantic-water, they will then be in icewater, which is a little, but not much, colder than the Atlantic-water. The quantity of salt in this icewater has been somewhat increased by its coming into contact with the salter icewater underneath, and possibly also by its being mixed with Atlantic-water. The specific gravity of the surface-water cannot surpass the specific gravity of the Atlantic-water by any of these processes; the surface stratum of the icewater accordingly can not sink under the Atlantic-water and consequently the bottles cannot in this way pass into the Gulfstream.

The bottles thus being unable to pass the line of contact between the Polar-current and the Gulfstream, we must suppose, that surface-water from the Polar-current can pass over the water of the

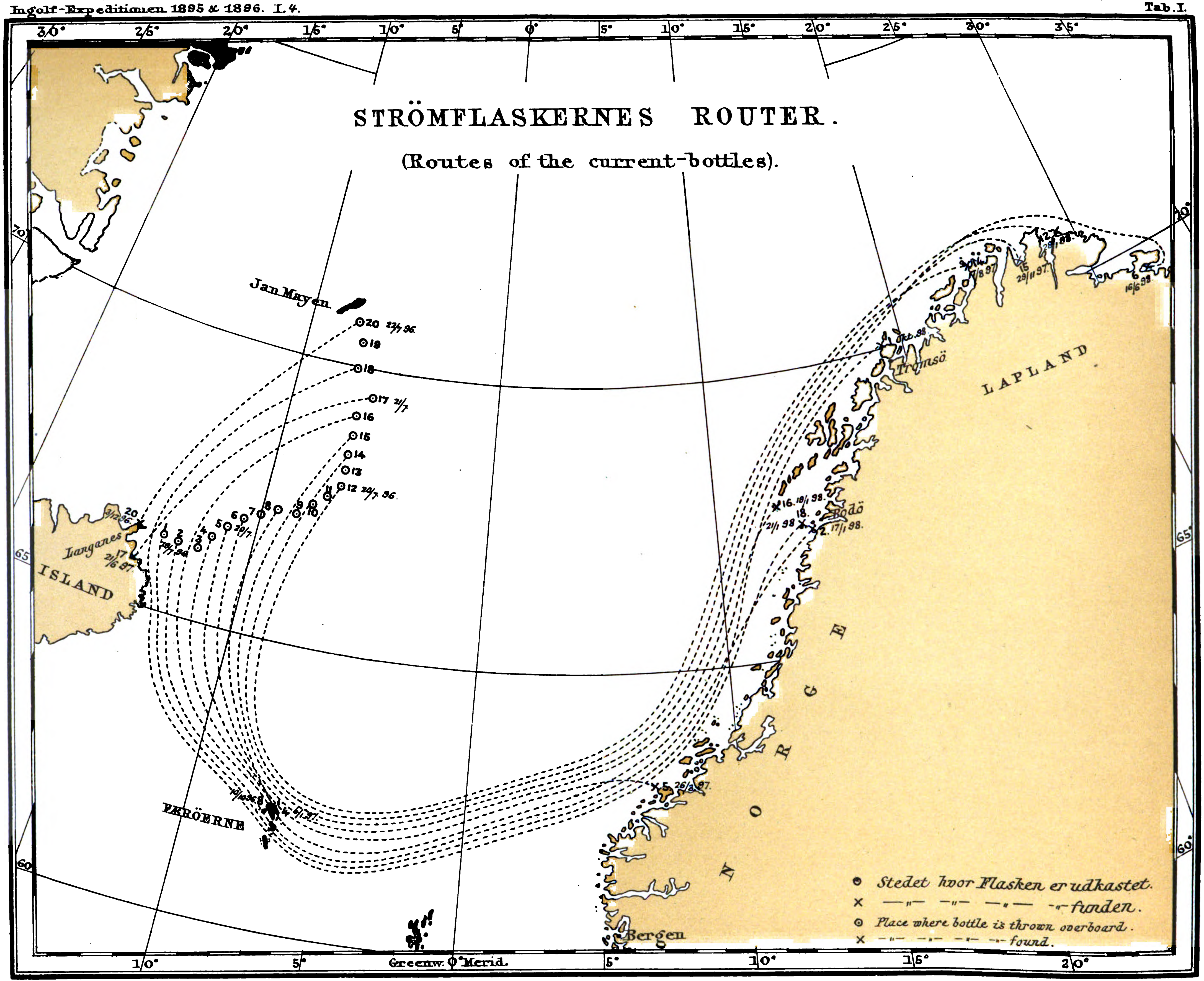
Gulfstream from the Færoe-Islands to Norway. We must suppose, that this is a fact, caused by the frequent southwesterly winds, but at the same time it seems strange, that this has not been proved long ago or at least hitherto fully proved. Still it must be remembered, that the temperature has always been used for deciding in former times between Polar-water and Atlantic-water, but as regards surface-water this way of deciding is unreliable, the Polar-current-water far down South having in the autumn and the first part of the winter almost as high a temperature as the Gulfstream-water.

It must be reserved for future hydrographical observations to state more exact details with regard to this, as it would be most interesting to have light thrown upon these matters (which are most important in the interest of the fishing), especially as regards the presence of the Polar-water in the Skager Rack.

The result of the drifting of the bottles thrown has accordingly confirmed the supposition, which existed concerning the rotation movement in the Northern Ocean, and has given an idea as to the speed of the same.

STRÖMFLASKERNES ROUTER.

(Routes of the current-bottles).



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